HIGH-YIELDING WHEAT VARIETIES NOT PROJECTED TO INCREASE FARMERS' RISK

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Crop breeding for main food security crops like wheat is challenged by future climate change. Great uncertainty exists concerning the consequences of breeding for higher yields in current climate on future crop yield levels and stability under climate change. Indeed, yield stability is a critical consideration for both farmers in adopting new technologies as well as for markets and food security. Within the project IWYP, ZALF researchers used process-based crop models capable of reproducing the responses of breeders' selected traits to quantify the interactions between high yield levels and crop yield stability under climate change.

What are the consequences of breeding for higher yields in current climate for future crop yield levels and stability?

Global wheat yields have stagnated in recent decades, raising concerns about implications for global food production and security. As such, there is a need to assess breeding options to increase yields in the future. However, crop breeding is challenged by future climate change. Great uncertainty exists around the consequences of breeding for higher yields in current climate on future crop yield levels and stability. Indeed, yield stability is critical for decisions at different levels of agricultural systems, from farmers' criteria for adopting crop varieties to the design of policies. Process-based crop models considering improved traits can quantify the interactions between crop traits and climate factors to allow assessing both average yield levels and yield stability under climate change.

Our model-based study first considered data from a series of breeding trials with high-yielding varieties in New Zealand, Argentina, France, Chile and Mexico for model improvement and testing. In a following simulation experiment contrasting current varieties with new varieties based on the traits selected by physiological breeders, we conducted simulations for 34 global high-yielding wheat producing regions. Our simulation results confirmed theoretical expectations that increased radiation use efficiency and, to a much lesser extent, improved fruiting efficiency lead to higher yields than current varieties across all study regions. While higher yields from improved traits were generally associated with increased inter-annual yield variability (measured by standard deviation), the relative yield variability (as coefficient of variation) was largely unchanged between current and improved varieties. Despite a higher sensitivity to the harshest environmental conditions selected from these high-yielding environments, improved crop lines still outperformed the base genotype over the range of the environments tested. In this context, improved wheat under future climate change would remain a low-risk crop for farmers and the adoption of high-yielding cultivars should not be hindered by their yield variability.

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